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CEA Multiplexed PDV (VHM in French)

Jacky BENIER

Patrick MERCIER

Virgile GUYOT

PDV Workshop 2018

OVERVIEW

Introduction

- motivation and goal.

Which multiplexing: 3 possibilities

- 4 signals in time per digitizer input,
- 8 signals: 4 signals in time with 2 frequencies.
- 8 signals in time per digitizer input,

High Explosive experiments to choose

Conclusion

MULTIPLEXED PDV: MOTIVATION AND GOAL

Increase number of velocity lines

- goal: record 128 velocities per experiment,
- increase signal number per digitizer channel (PDV: 1 velocity per channel),
- take into account the system radiometry,
- improve the line inspection with reflectometer Luna OBR4600.

Modify the PDV chain design

- reduce volume and cost per line, while improving new functionality,
- upgrade current PDV: too many components change
  - ➢ easy to develop a new design

Studied solutions

- time or frequency multiplexing,
- 3 designs were studied:
  - ➢ 4 in time per input (laboratory test),
  - ➢ 4 in time and 2 in frequency per input (shot test),
  - ➢ 8 in time per input (shot test).

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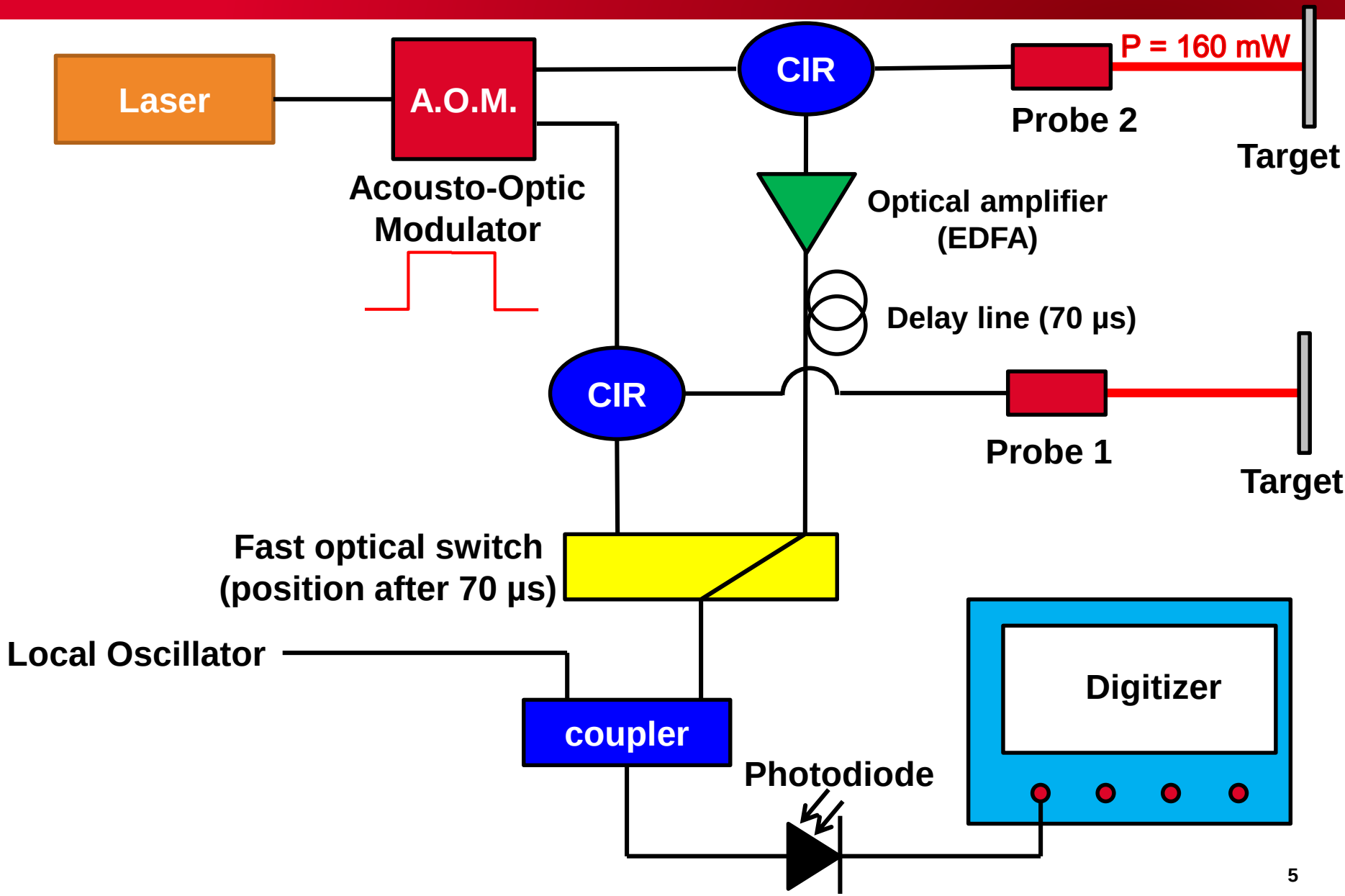
MULTIPLEXED PDV
HOW TO DO IT ?

PROTOTYPE DEVELOPMENT TO TEST 3 CONFIGURATIONS

MAIN CONFIGURATION



PROTOTYPE CHAIN DESIGN TO TEST 3 CONFIGURATIONS

Synchro command

digitizer

Photodiode module

Electric coupler

4 in time multiplexer 1

4 in time multiplexer 2

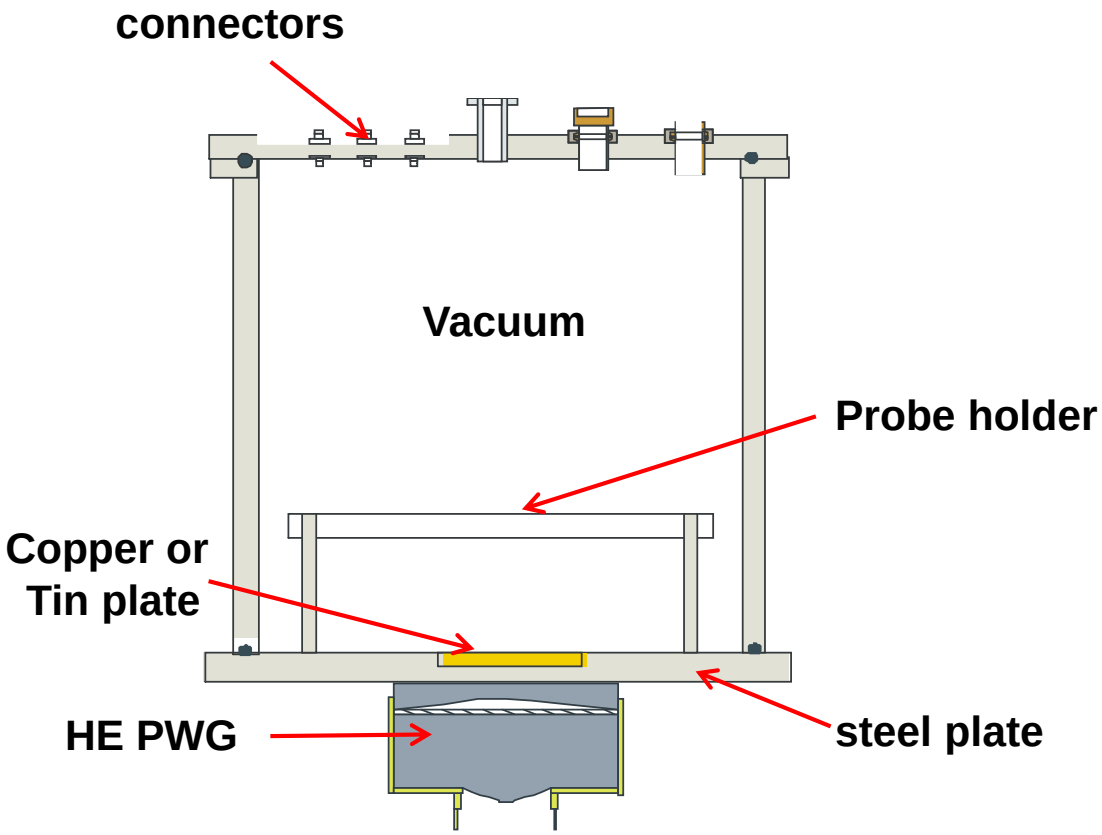
Lasers and combination module

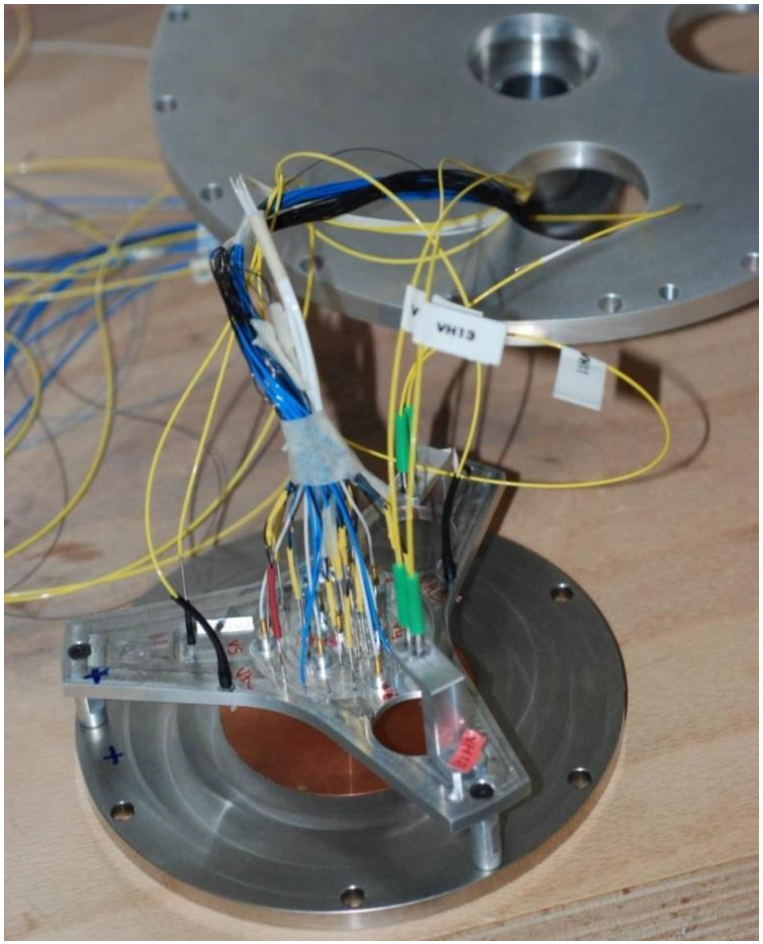
Setting configuration

- ❑ 4 in time
- ❑ 8 in time
- ❑ 4 in time x 2 in frequency

MULTIPLEXING TESTS : 2 HE Plan Wave Generator

Similar setup: metallic plate projected by a High Explosive Plan Wave Generator, under vacuum.





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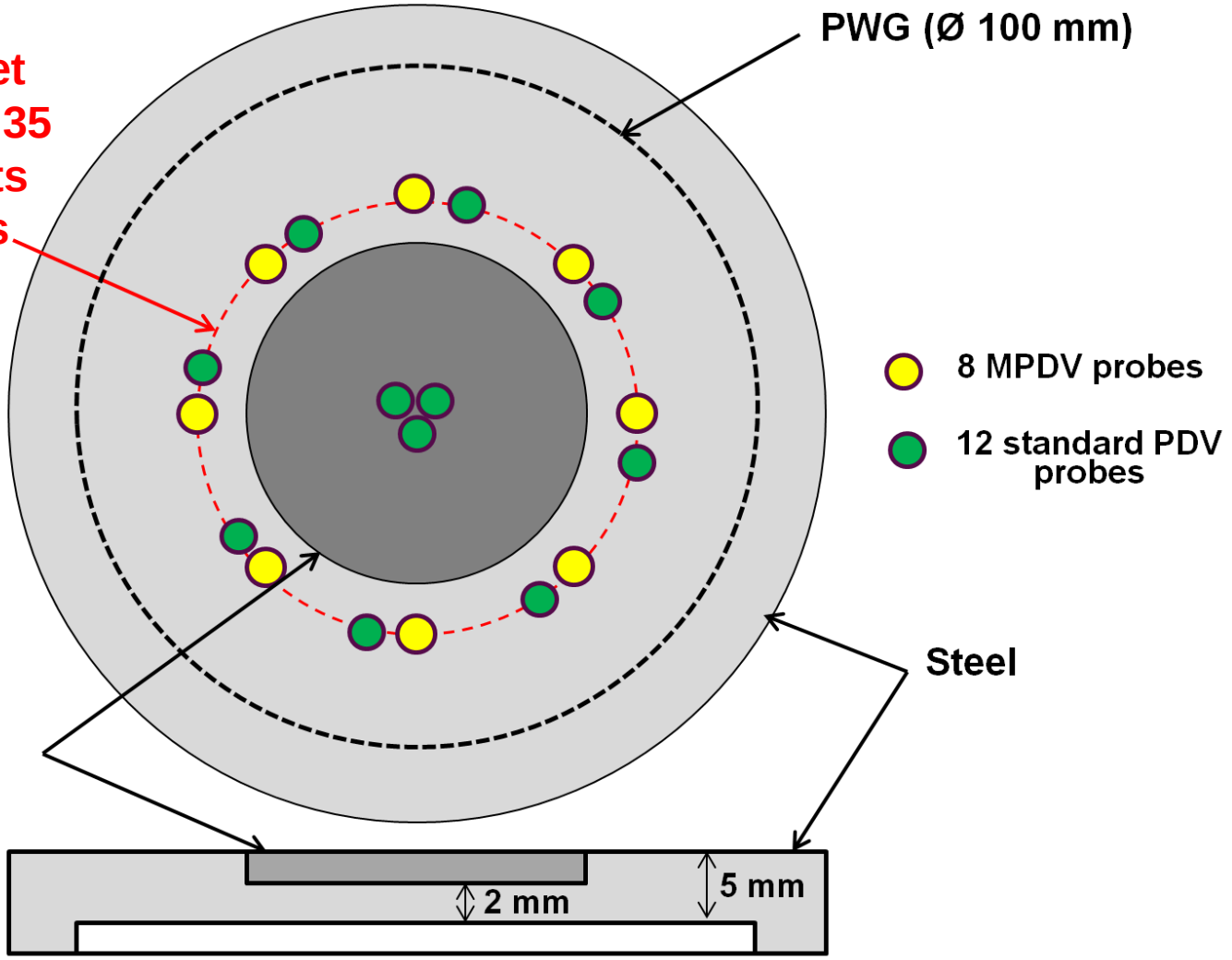
MULTIPLEXING
PWG SHOT 1:

X4 IN TIME
X2 IN FREQUENCY

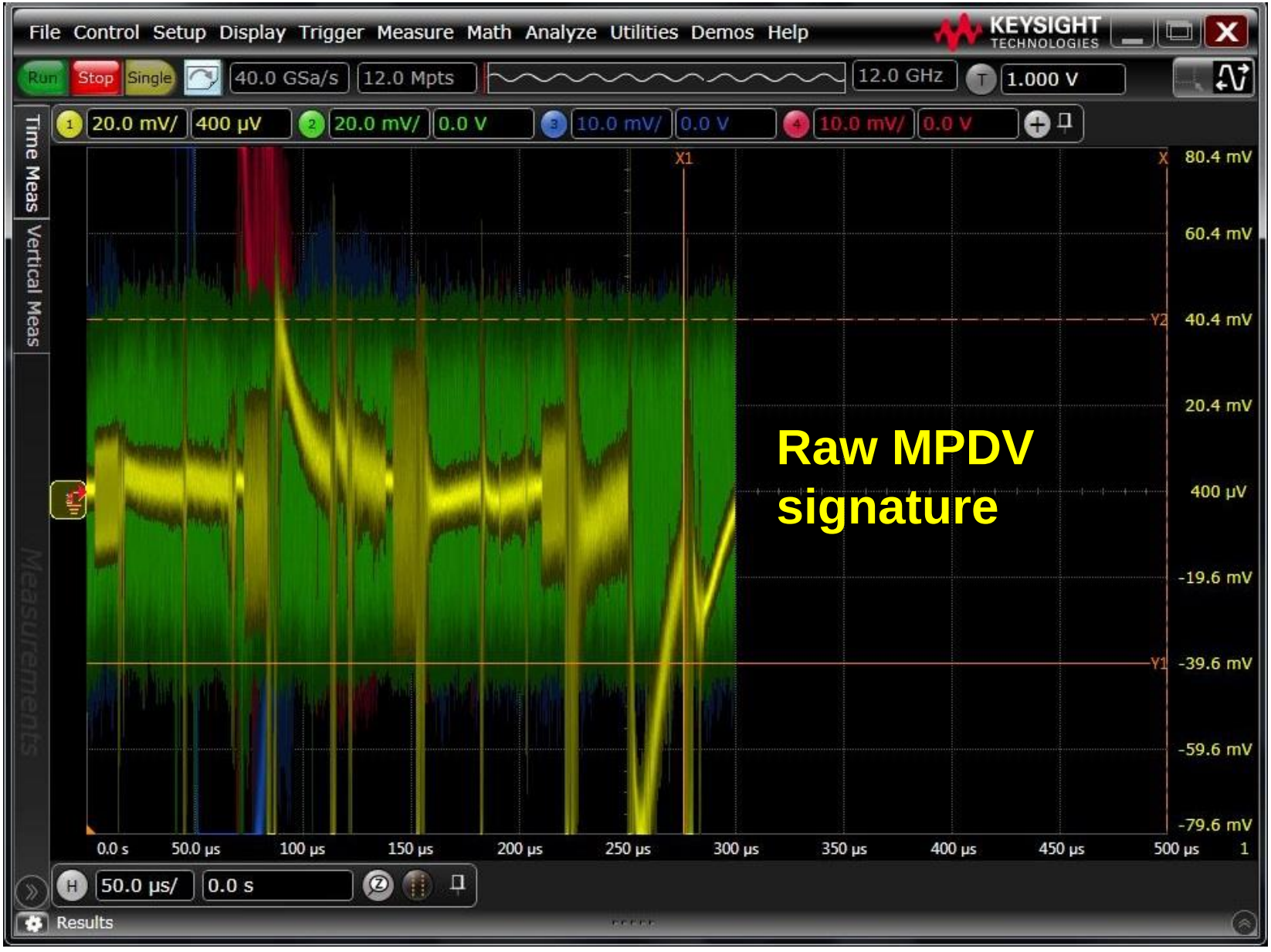
SHOT 1 SETUP (4 TIMES - 2 FREQUENCIES)

16 PDV probes set on a circle (radius 35 mm): all breakouts are synchronous



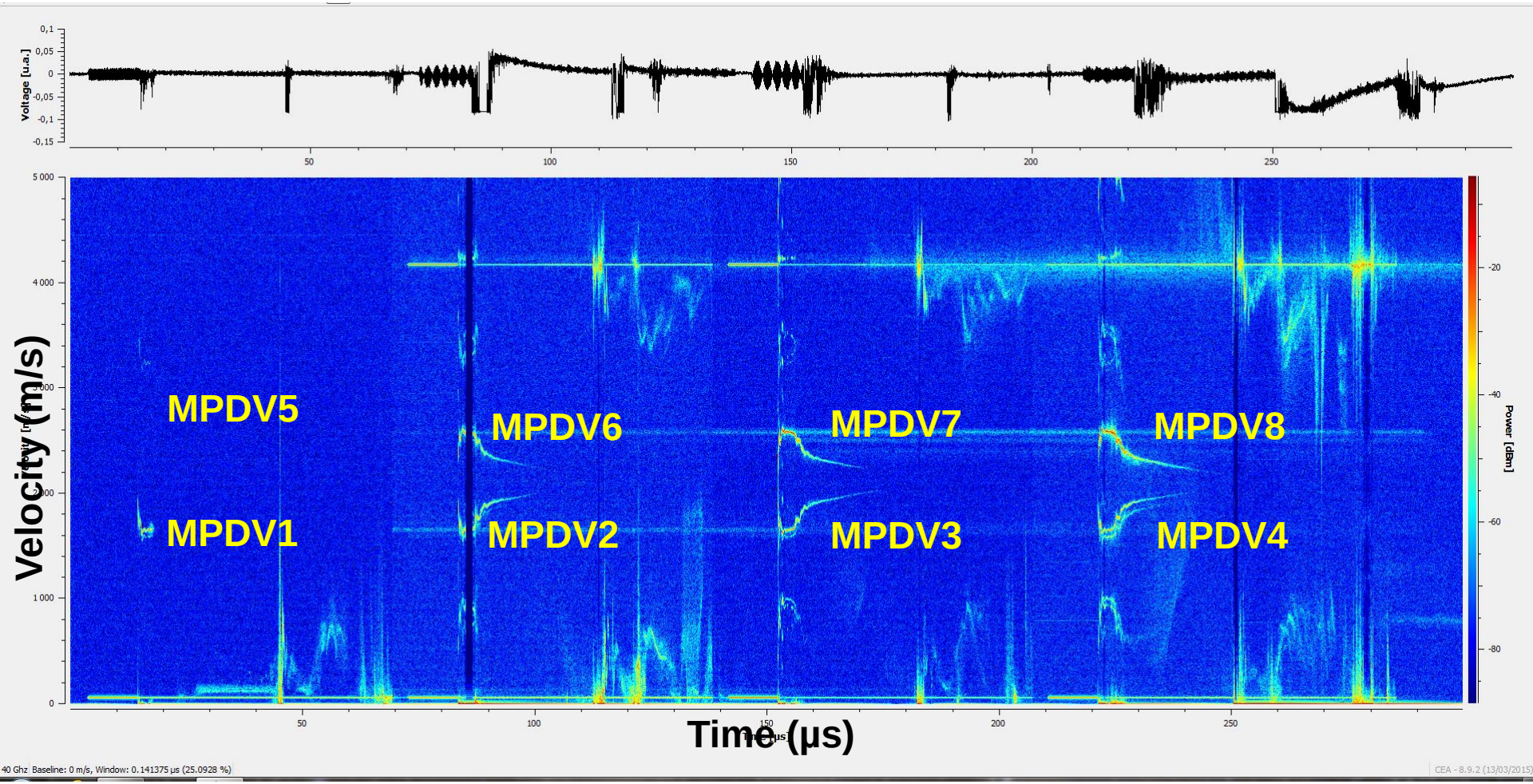
Goal: performance assessment and signal comparison with standard PDV

SHOT 1: RAW SIGNATURE RECORDED ON DIGITIZER (each time slot = 70 µs, or 280 µs for 4 double slots)

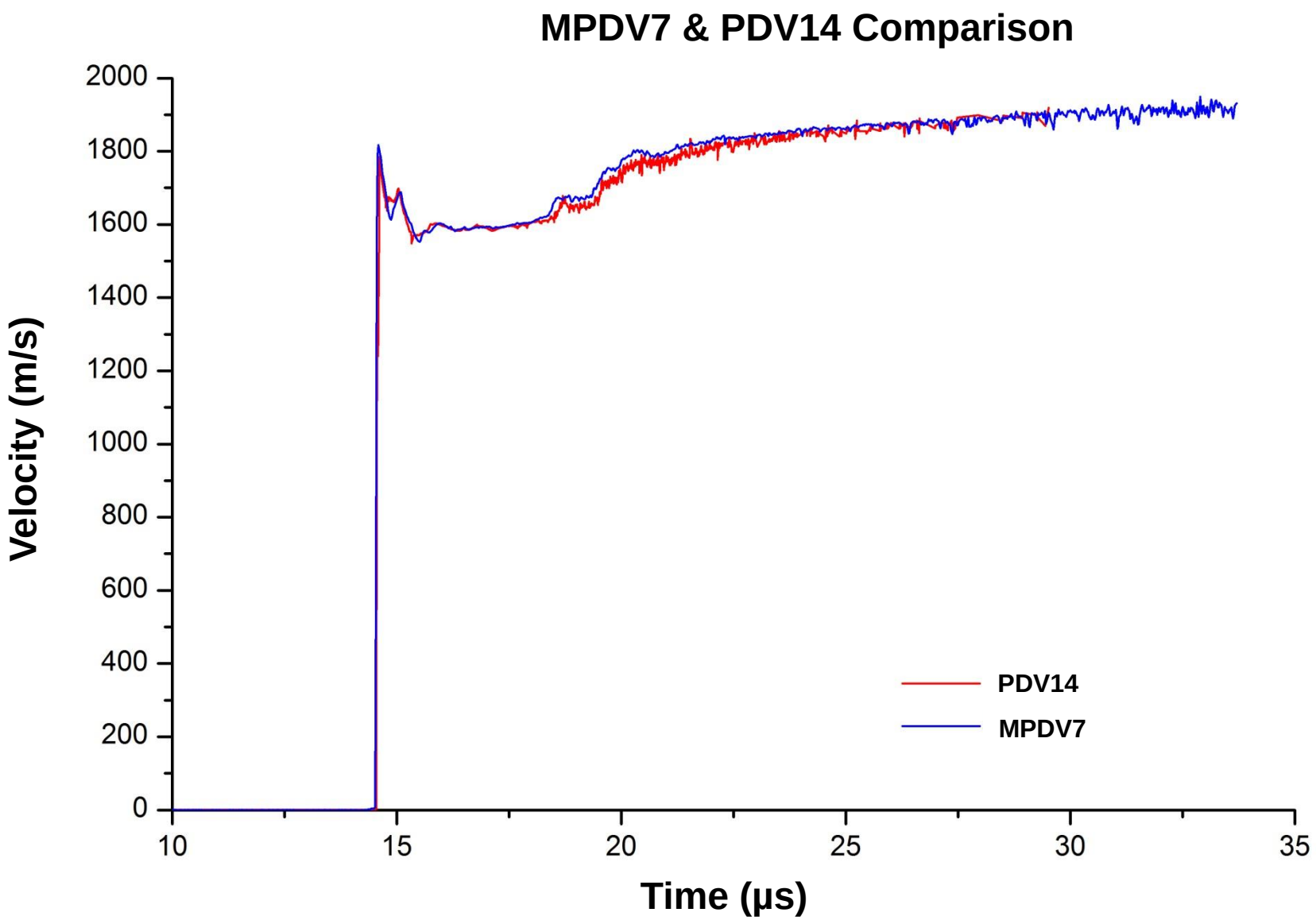


AFTER FFT ANALYSIS

Probes are located on the same radius (synchronous signal)



COMPARISON BETWEEN STANDARD (PDV14) AND MULTIPLEXED PDV (MPDV7)



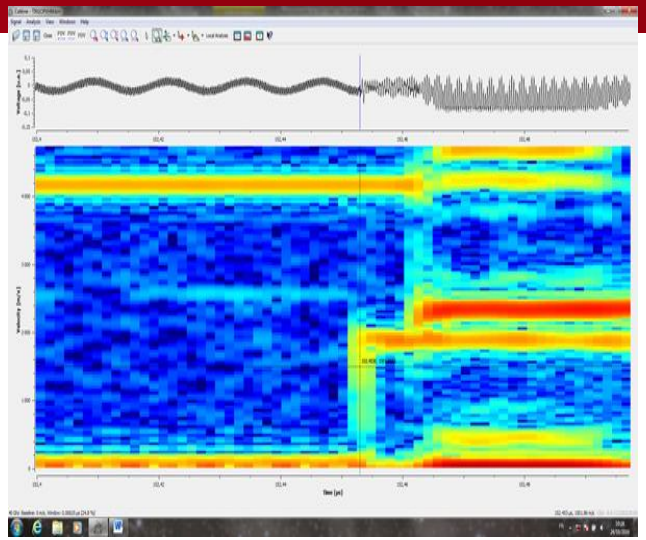
TIME CORRECTION CHECKING USING ACOUSTIC OPTICAL MODULATOR (A.O.M.)

Channel	A.O.M. Timing ref. (µs)	shock breakout time (µs)	DT (µs)
MPDV1	3.951	14,632	10,681
MPDV2	72,857	83,549	10,692
MPDV3	141,775	152,453	10,678
MPDV4	210,684	221,356	10,672
MPDV5			
MPDV6	72,847	83,532	10,685
MPDV7	141,775	152,462	10,687
MPDV8	210,684	221,371	10,687

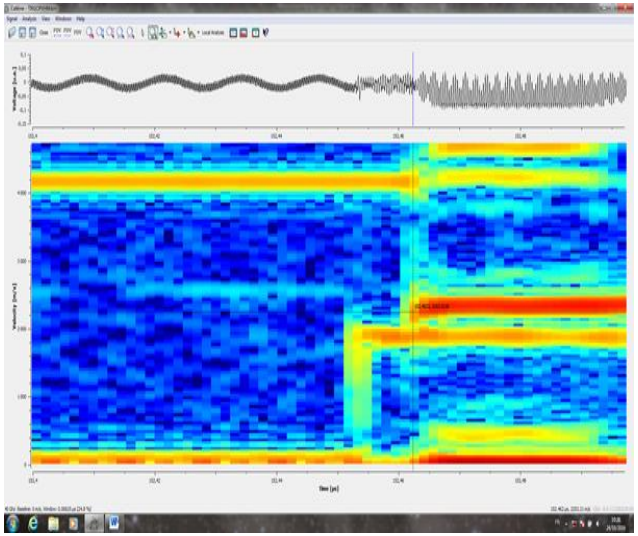
Largest shift: 20 ns

DT ± 12 ns (2s)

A.O.M. is good time reference



MPDV3 time = 152,453 µs



MPDV7 time = 152,462 µs
DT = 9 ns

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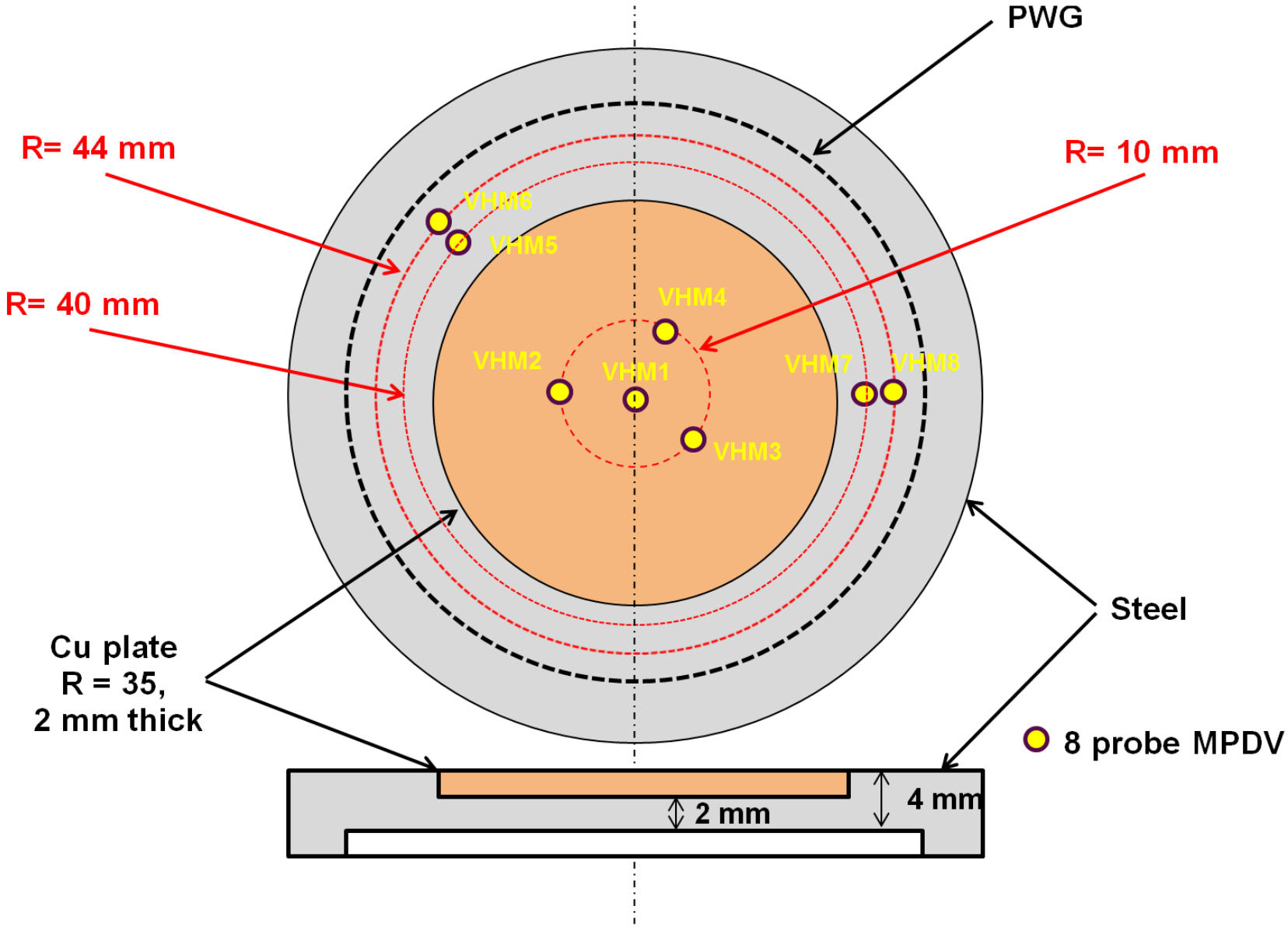
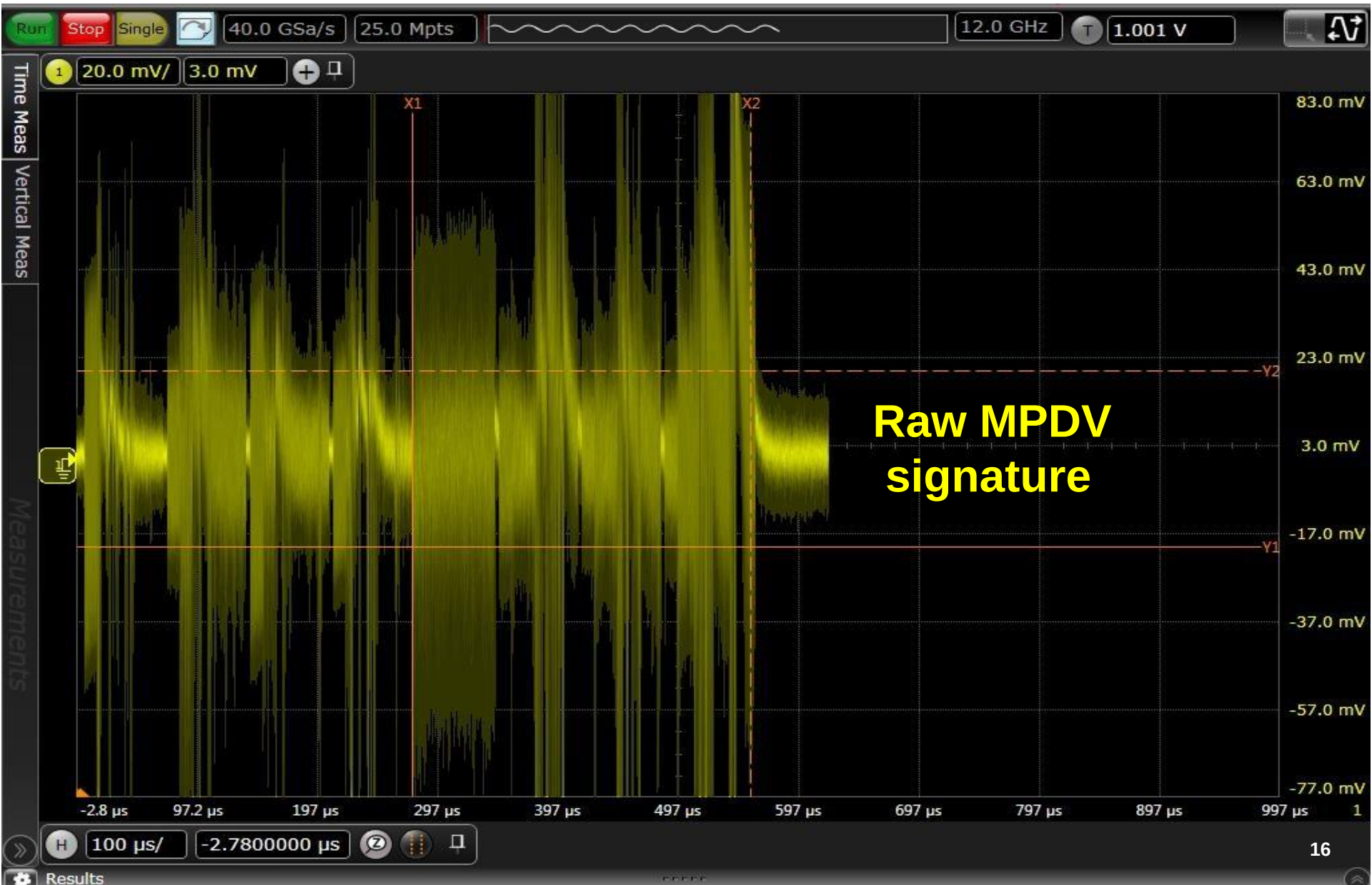
MULTIPLEXING PWG SHOT 2:

X8 IN TIME

Shot 2 setup (multiplexing x8 in time)

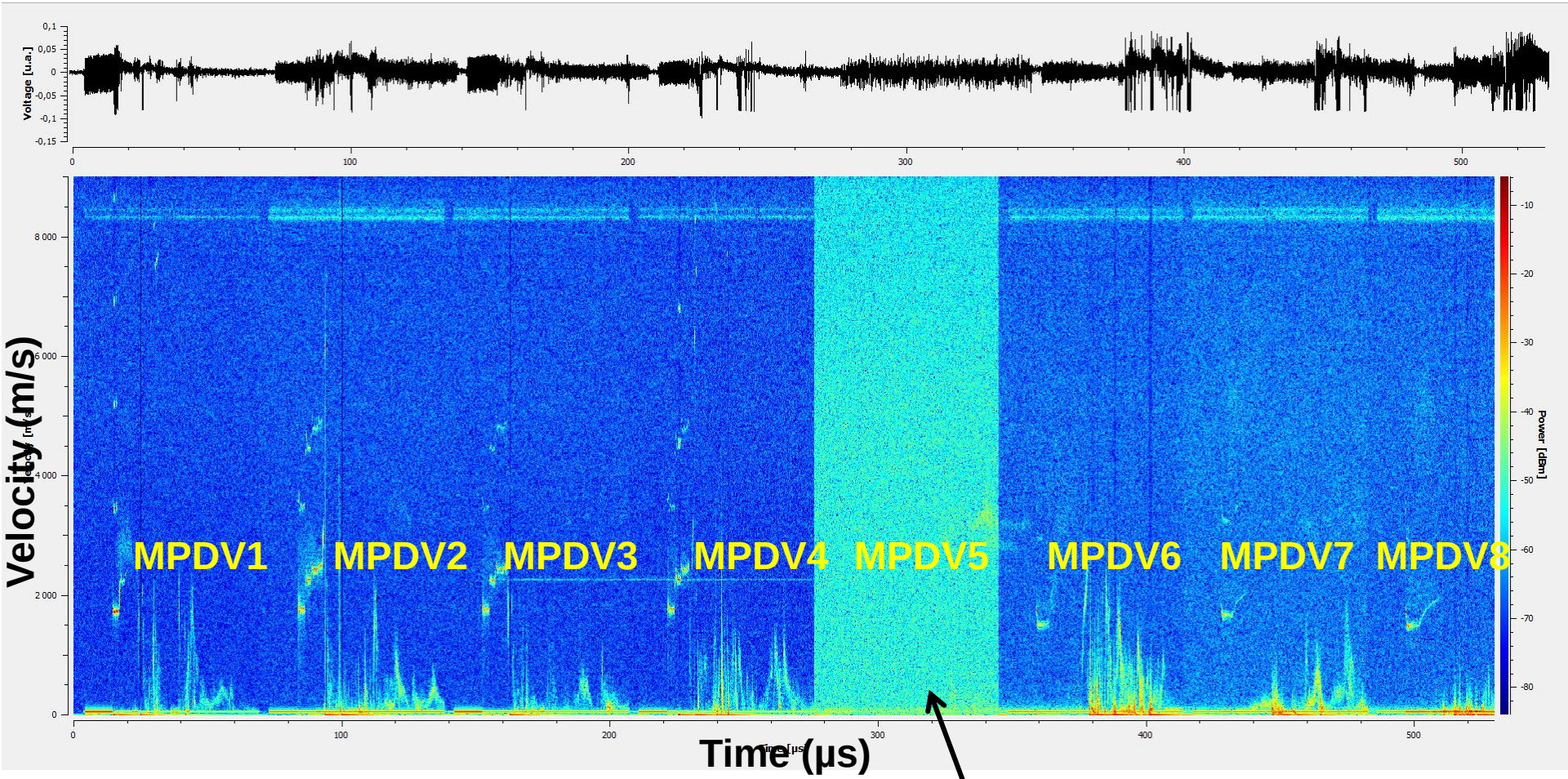


SHOT 2: RAW SIGNATURE RECORDED ON DIGITIZER (only time multiplexing: 560 µs for 8 slots)



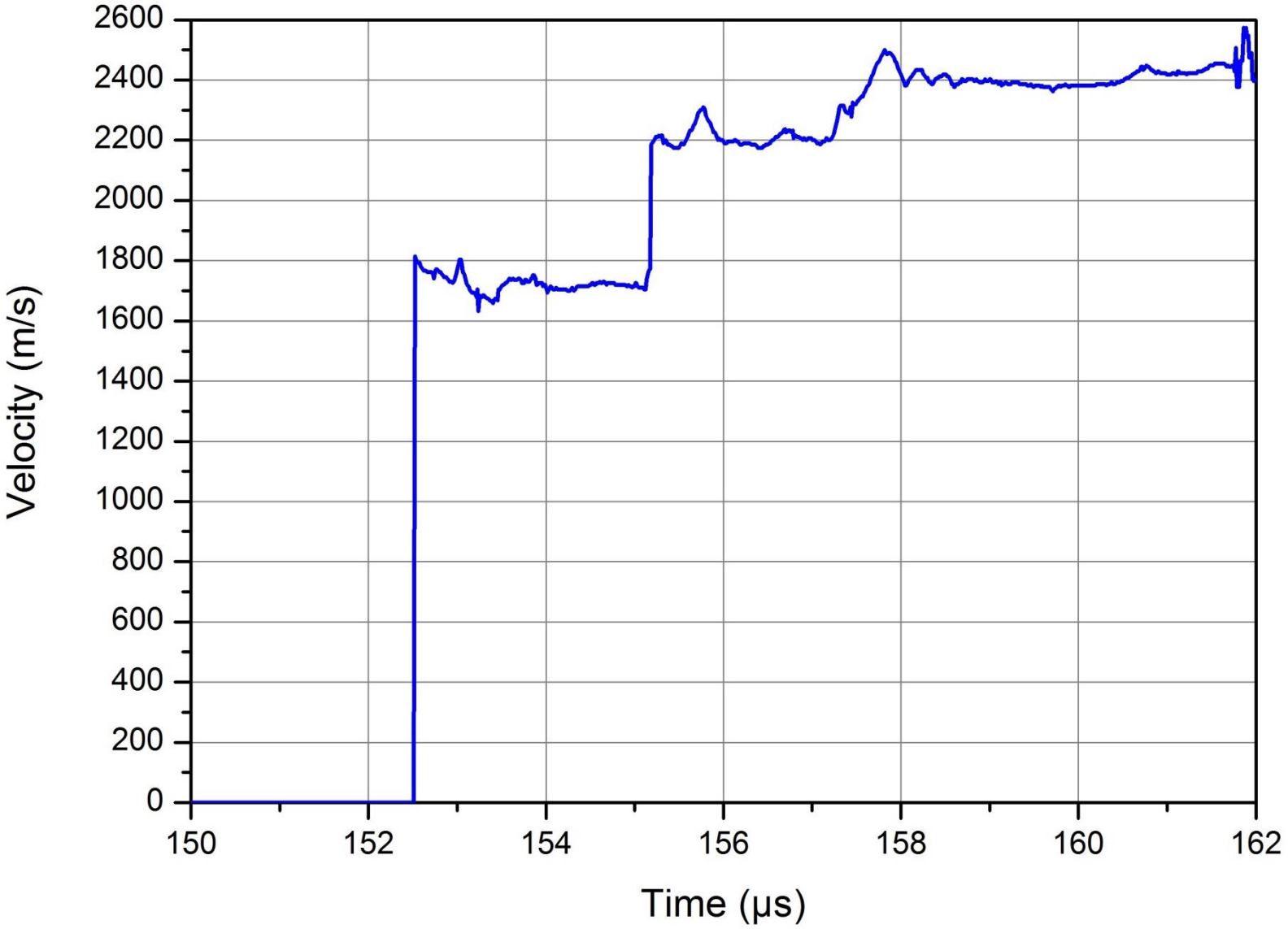
AFTER FFT ANALYSIS

Probes are not located on the same radius (different signal shapes)

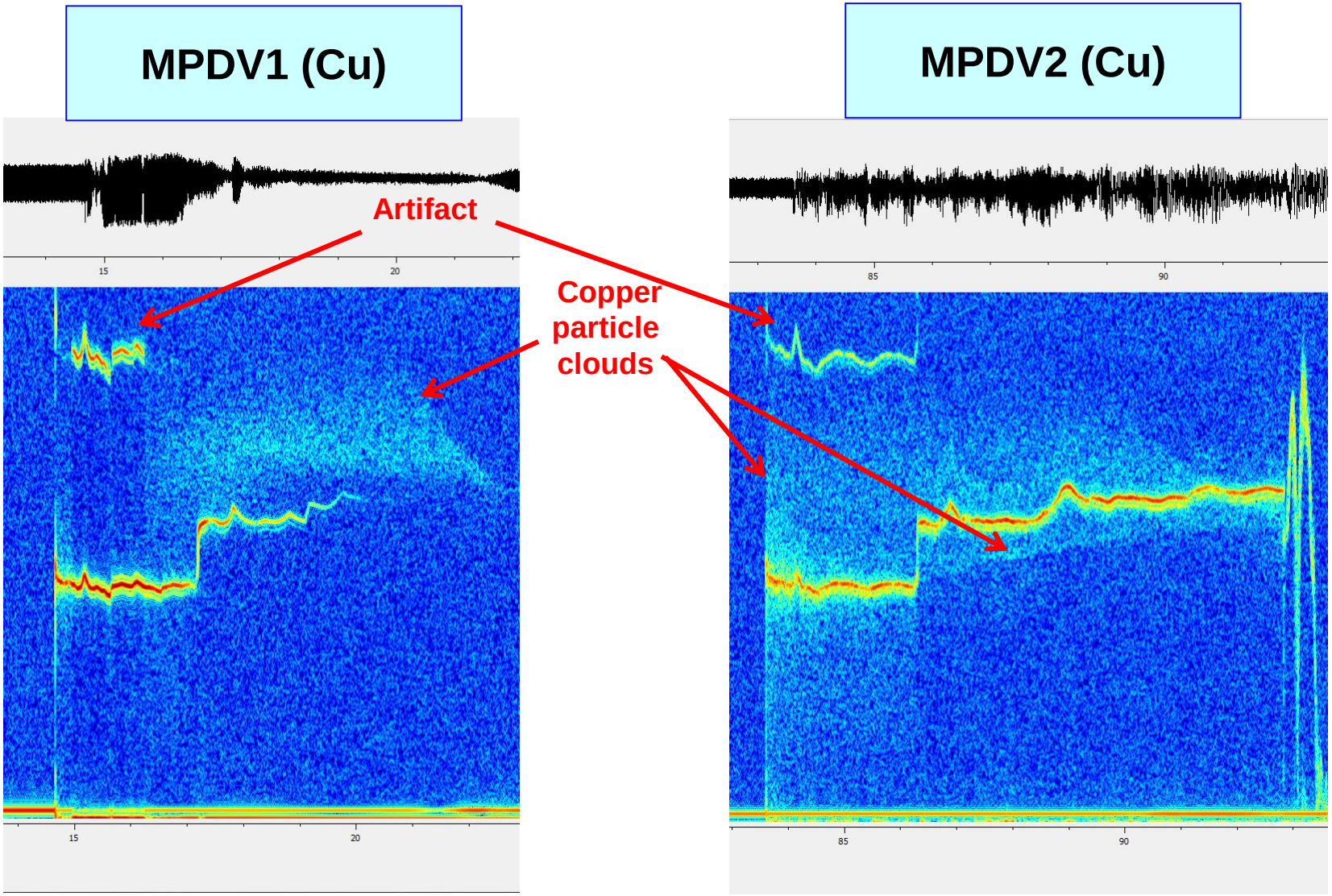


Broken fiber

EXTRACTION OF COPPER FREE SURFACE VELOCITY (MPDV3)



SPECTROGRAM ANALYSIS



CONCLUSION

Signal Analysis

- particles are detected,
- A.O.M. is a good timing reference,
- 2 configurations were tested on dynamic experiments and both are relevant.

Chosen configuration: 8 PDV in time per channel

- easier for pre-shot tuning,
- easier to analyze: 1 signal per time slot,
- if signal saturation: only 1 lost signal,
- delay lines attenuation were compensated by EDFA,
- deep memory on digitizer isn't a problem anymore,
- **this development has been used to build a MPDV system with 32 channels per cabinet**.

IDIL FIBRES OPTIQUES

ANY QUESTIONS ?

Thanks you for your attention